STATUS REPORT ON THE LACARA EXPERIMENT

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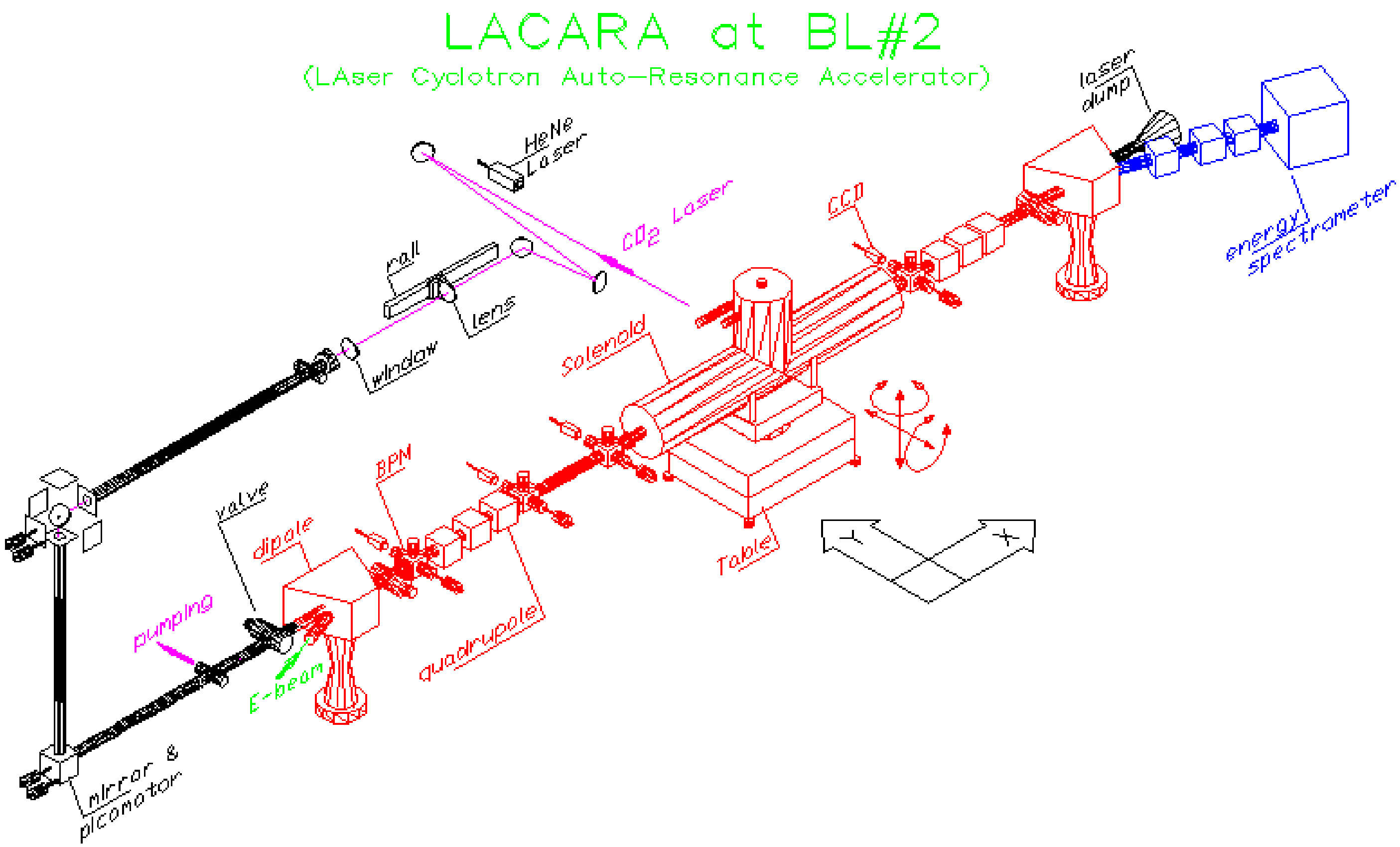


References:

1) J.L. Hirshfield, C. Wang, Physics Rev. E 61, 7252 (2000)

2) T. C. Marshall, C. Wang, J.L. Hirshfield, Physics Rev. Vol. 4. 121301, (2001)

3) S.V. Shchelkunov, T.C. Marshall, J.L. Hirshfield, C-B. Wang, and M.A. LaPointe, p. 349, AIP Conference Proceedings 647: Advanced Accelerator Concepts Tenth Workshop, Editors C.E. Clayton and P. Muggli, (2002)

LACARA - Laser Cyclotron Auto-Resonance Accelerator

* Vacuum accelerator of electrons

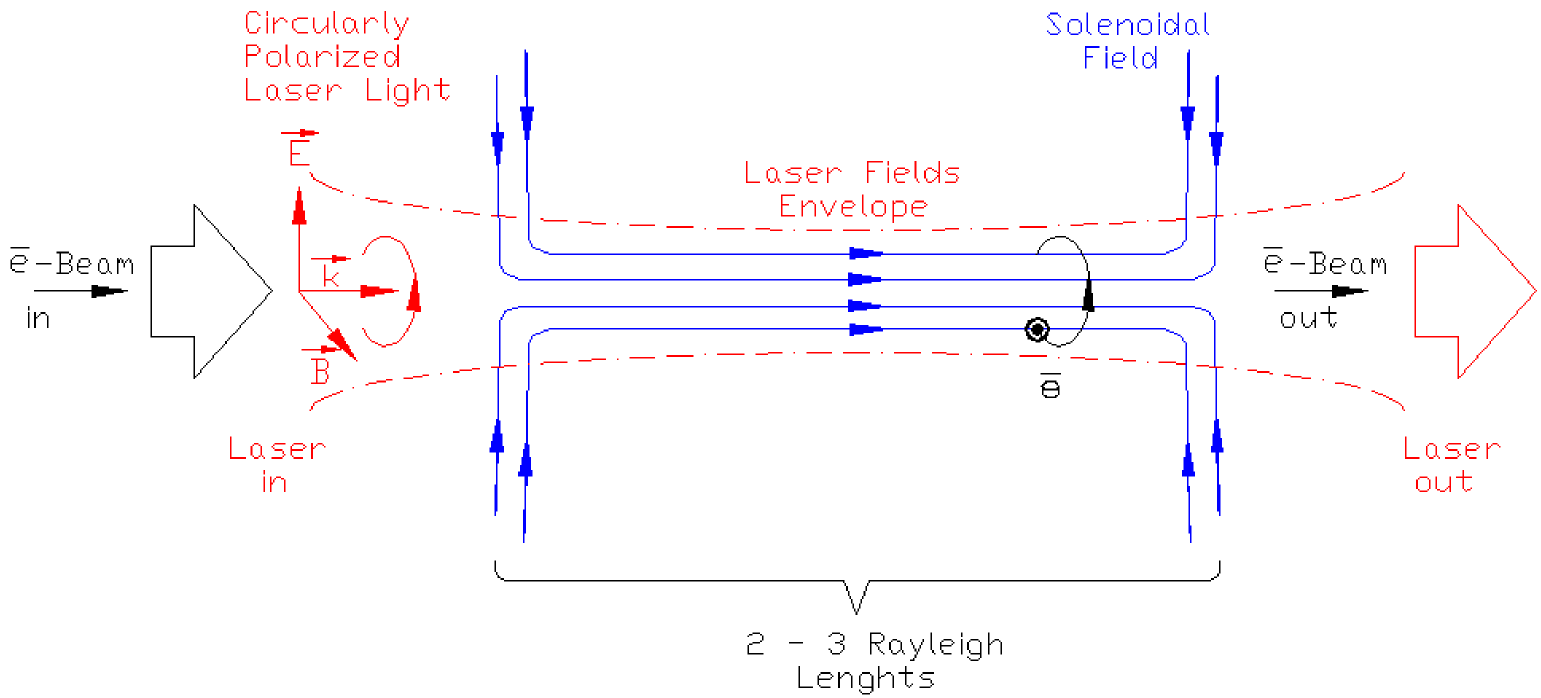
* Electrons gain energy by a nearly-gyroresonant interaction.

* The input electron beam is not pre-bunched ($\sigma \approx 100\mu m$, emittance $\approx$ 0.015mm-mrad) and <u>all electrons receive</u> the energy increment

* A 50MeV bunch should gain another 25MeV in <1m using ~0.8TW CO_2 laser power

useful features:

- * The utilization of high laser power in the form of a Gaussian beam
- * Acceleration to a high energy over a short distance
- * Possibility to make f-sec bunches



LACARA Schematic.

requires:

* Gaussian laser beam (λ = 10.6μm) with a Rayleigh length ≈50 - 60cm

* ~6T solenoidal field (provided by a "dry" SC magnet)

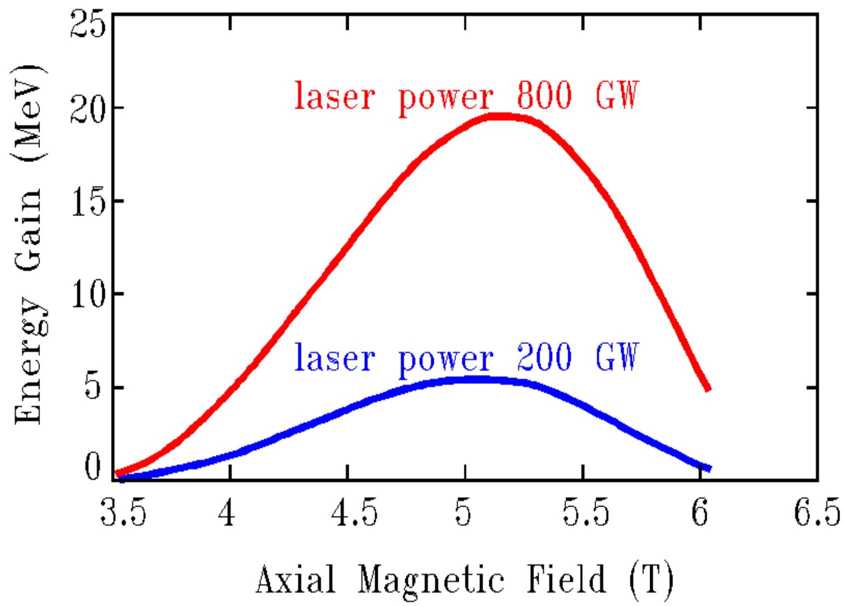
the PRINCIPLE of RESONANCE
between the electrons and the parallel-moving light pulse

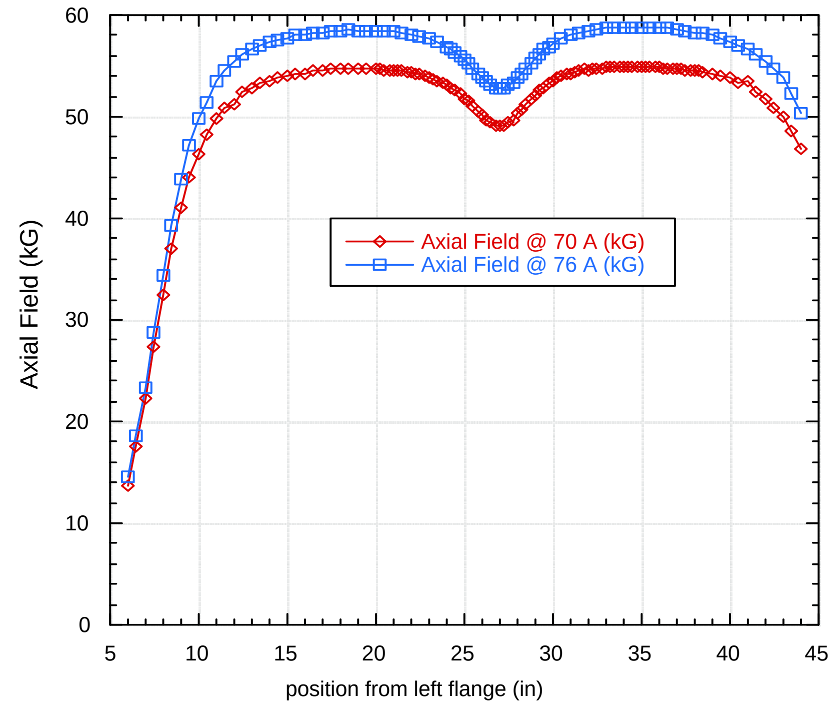
* LACARA uses a TW, circularly-polarized Gaussian-mode Carbon Dioxide laser and a solenoidal magnetic field for acceleration.

* Laser photons will travel in the same direction as the electrons, and therefore the Doppler-shifted laser frequency in the electron rest frame must be $\gamma\omega\,(1 - n\beta_z) = eB/m = \Omega o$ for gyro-resonant interaction

* During the motion of the electron, an increase of γ and an increase of β_z is compatible with a fixed laser frequency ω, because the behavior of the effective index of refraction $n = [c/\omega\,]\,[\,k_z + k_r\,(v_r/v_z)]$ upon position will determine the details of the energy gain. Since both $(1 - n)$ and $(1 - \beta z)$ are $<<1$, it follows that $\Omega o\,/\omega \sim 1/2\gamma$.

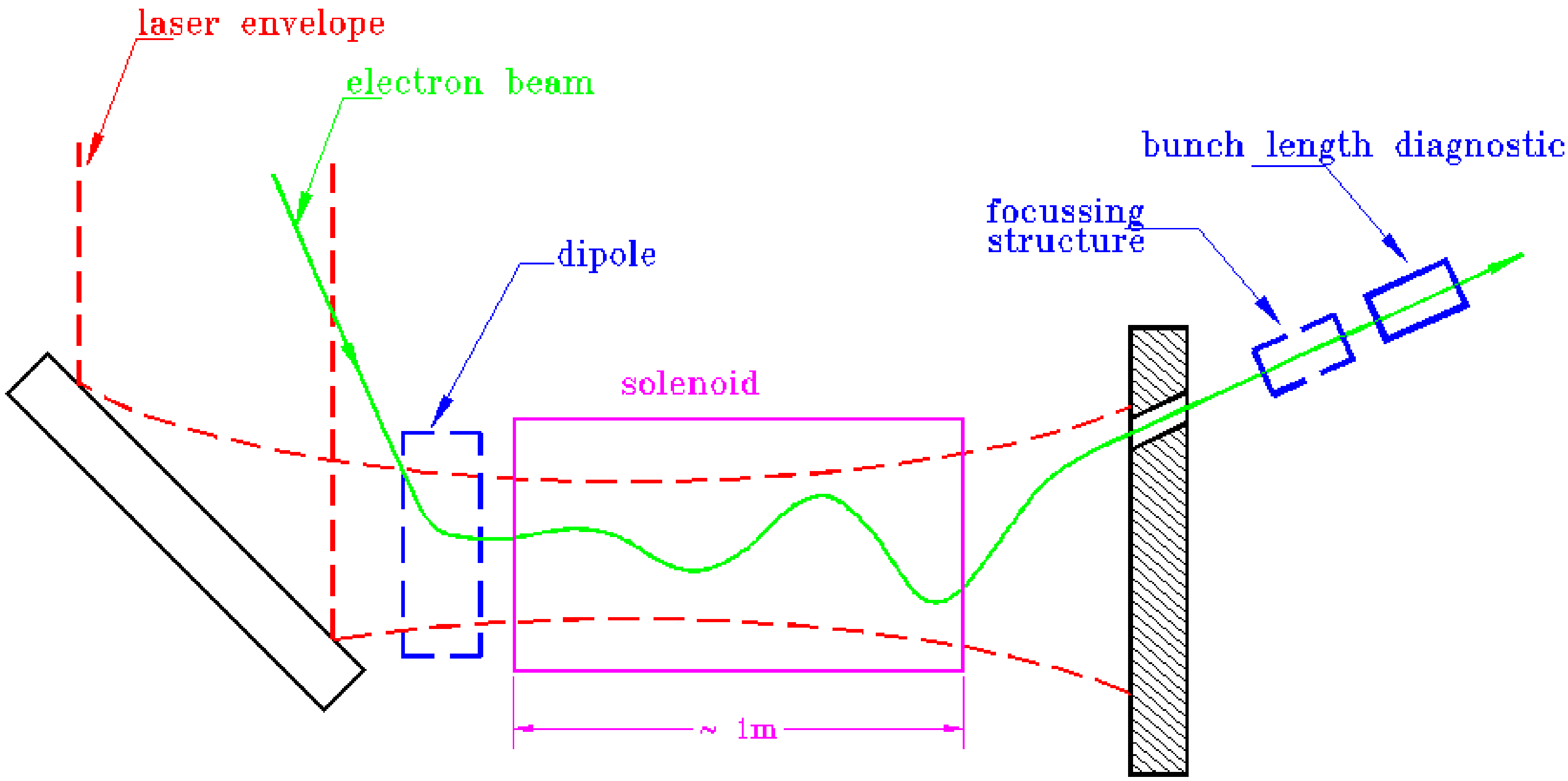
* An almost constant solenoidal field is used; this is possible because the resonance condition above is relaxed since the entire path of the bunch is only a few gyroperiods in length.



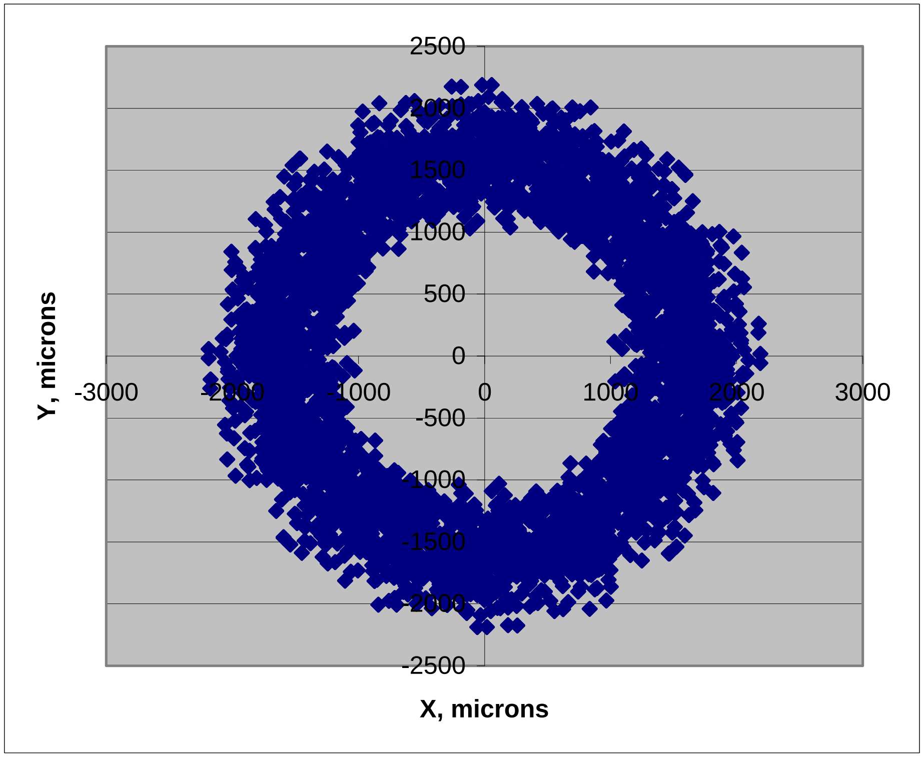


		$\sigma \approx$ 101 µm, $\varepsilon \approx$ 0.015 mm-mrad			$\sigma \approx$ 30 µm, $\varepsilon \approx$ 0.0015 mm-mrad	
Laser Power, *[GW]*		Emittance, final, [*mm-mrad]*	Energy spread, final, *[%]*		Emittance, final, [*mm-mrad]*	Energy spread, final, *[%]*
30		.139	6.6		.033	2.0
800		.269	18		.092	2.7

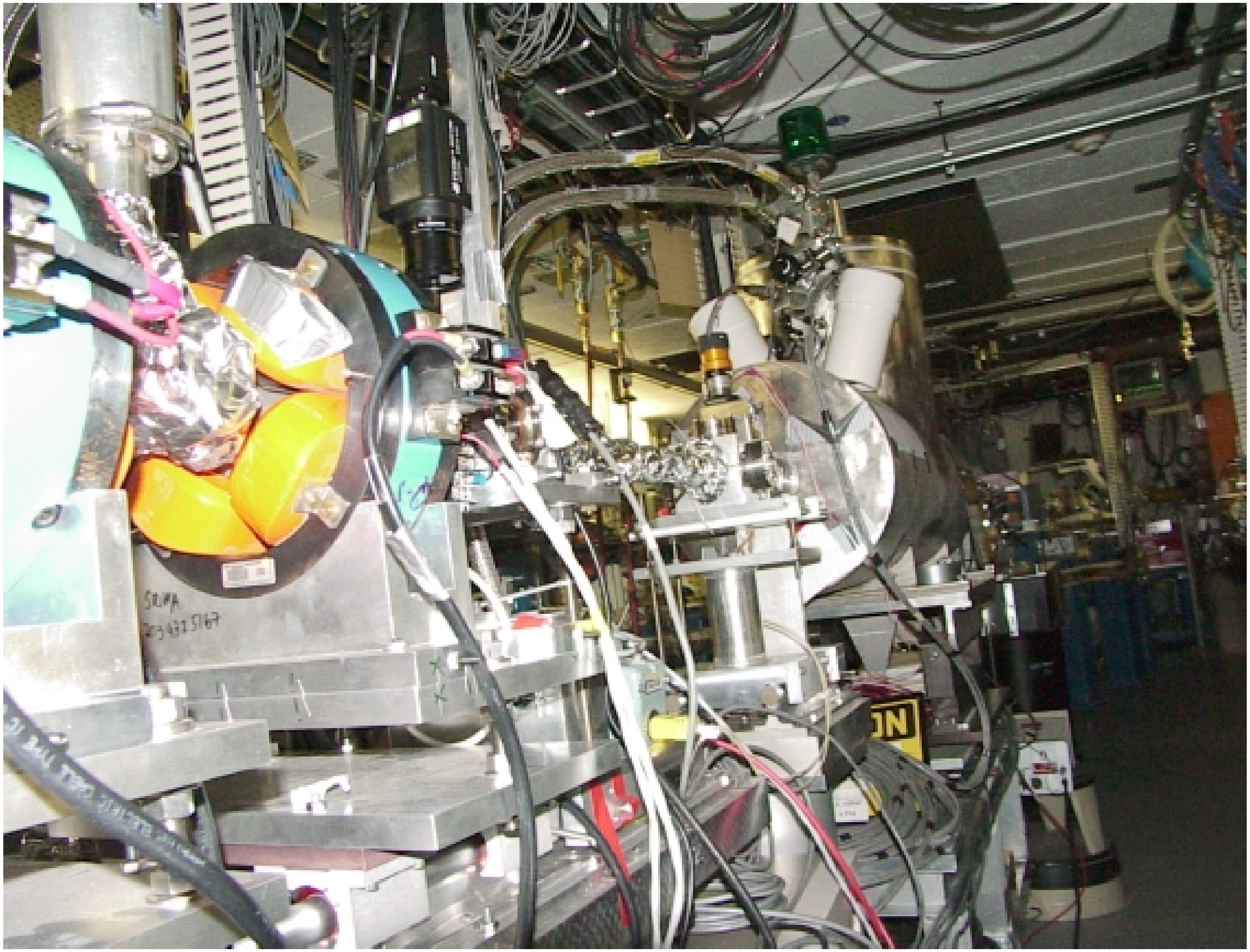
fsec bunch production

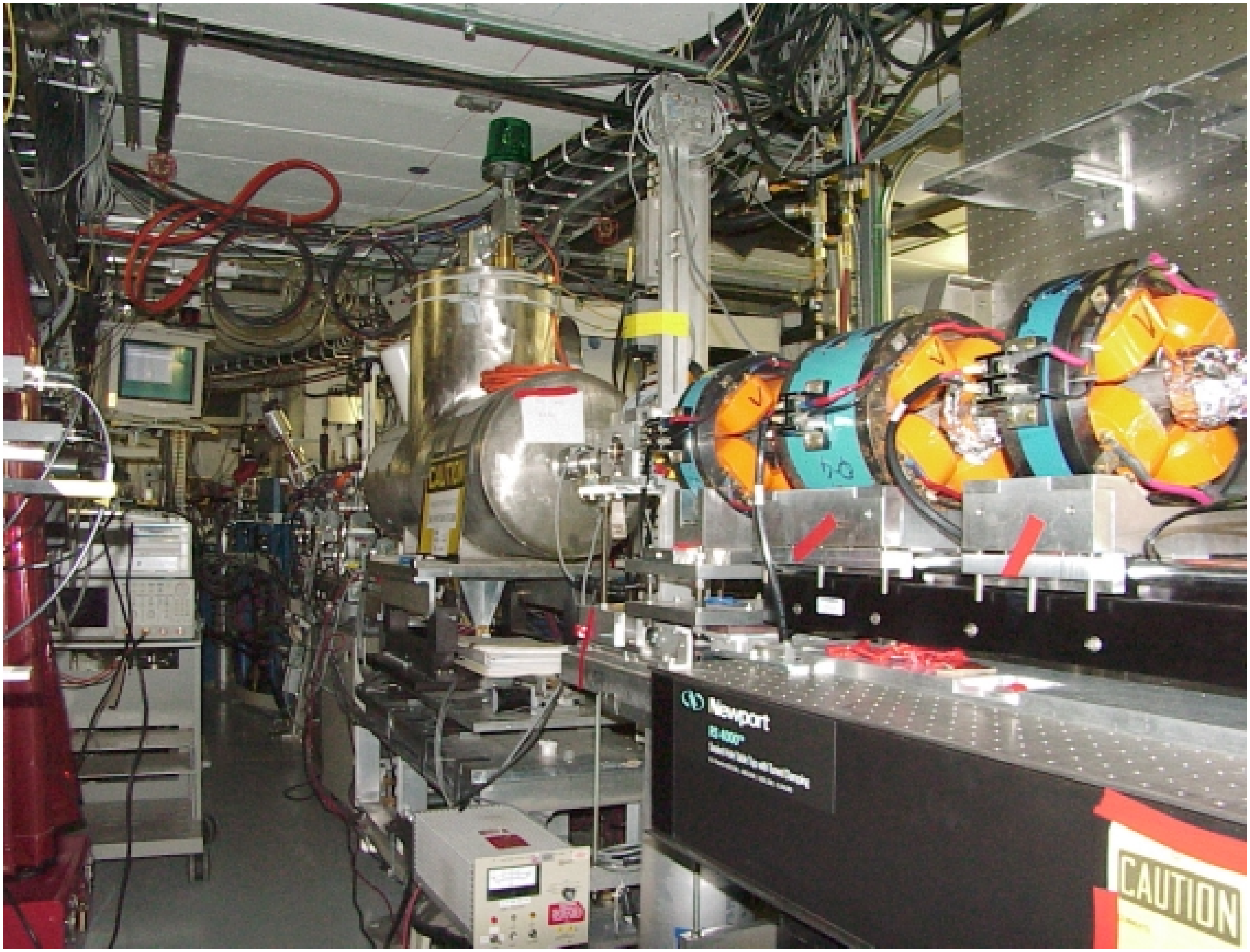


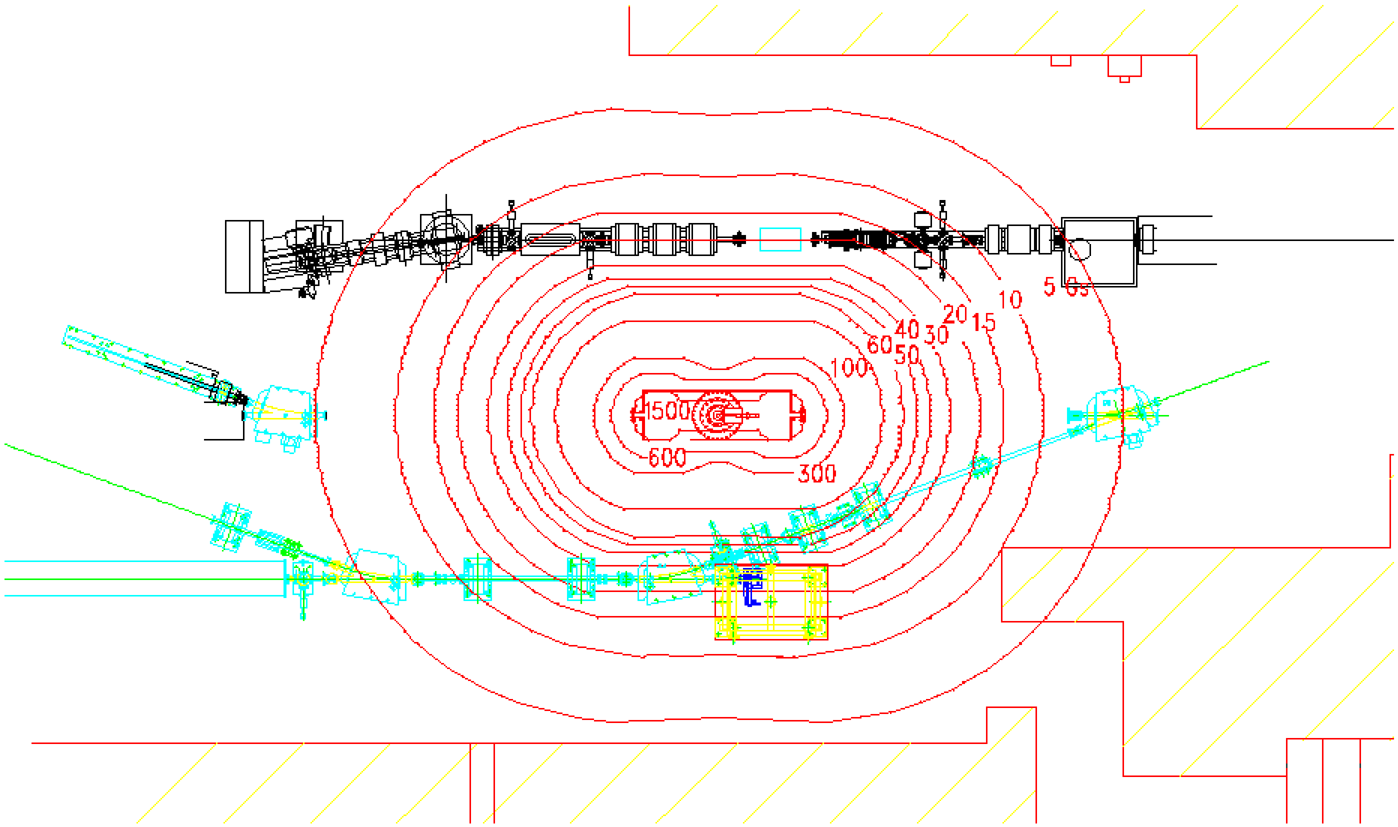
NOTE: not to scale



A “snapshot” of the transverse particle positions on a plane, following acceleration. The laser power ≈ 800 GW; the electron beam at the matching point is round with the waist $\sigma_{x,}\, \sigma_y$ = 28 μm, and the non-normalized emittance is .0015 mm-mrad.



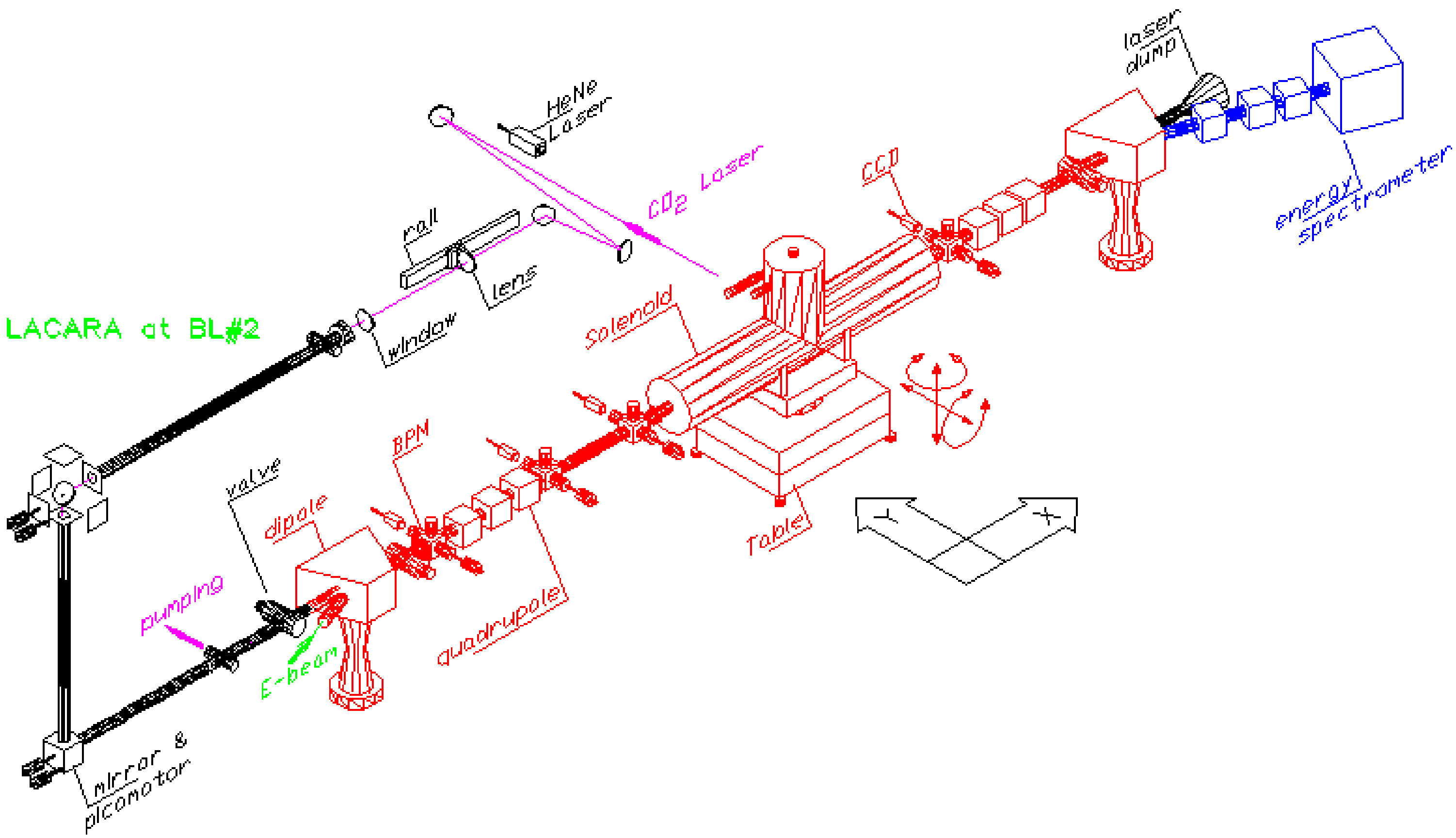

Newport
CAUTION



Values of magnetic field, if the field inside is 6T (confirmed by measurements in the high bay)

NOTE:

LACARA may operate at 4 T, and thus, all values could be 1.5 times less



Electron Transport	Already assembled
Laser Transport	Feb-March of 2006
Preliminary Runs	April-July of 2006
New spectrometer	August-December of 2006